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SKP16C/28 FLGA

User's Manual

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1.0 Introduction

The SKP16C28 FLGA StarterKit Plus (SKP) is a low-cost development environment for evaluating M16C/28 group microcontrollers (MCU) and Renesas software development tools. The kit comes with a complete software development tool chain including, HEW (IDE, GUI, Debugger), NC30WA (C-compiler, assembler, and linker), and FoUSB (Flash-over-USB™ Programmer).

A real-time, source-level debug environment is implemented using the HEW debugging interface with the RTA-FoUSB-MON Flash Programmer/In-Circuit Debugger (ICD). The Flash-over-USB™ (FoUSB) Programmer software, with the ICD, allows in-system programming of the M16C/28 flash MCU.

The ICD and firmware provide a convenient USB (Universal Serial Bus) interface between the SKP16C28 FLGA board and the host PC. This interface reduces resource requirements on the M16C/28 MCU, allows faster code downloads and, can also be used with many other Renesas Flash MCU's, SKP's, and user's target board.

2.0 Contents of Product Package

This section describes the contents of the SKP16C28 FLGA product package. When unpacking your SKP16C28 FLGA, please check to see that all products listed below are included.

2.1 SKP16C28 FLGA StarterKit Plus Product List

Table 2-1 lists the products included in the SKP16C28 FLGA.

Table 2-1 SKP16C28 FLGA Product List

Product Name	Quantity	Remark
SKP16C28 FLGA Board	1	M16C/28 FLGA SKP Board
RTA-FoUSB-MON (ICD)	1	HEW Debugger/ FoUSB Programmer Interface Device
6” 10-Pin Target Cable	1	Connects SKP16C28 FLGA Board (J1) and the ICD
6’ Mini USB Cable	1	Connects ICD to the Host PC
SKP CD-ROM	1	Auto-install program HEW (IDE) NC30WA (C-compiler, assembler, and linker) FoUSB Programmer Manuals Tutorials Sample programs

2.1.1 SKP CD-ROM

The CD-ROM contains the electronic manuals and software necessary for developing programs. Your computer must have Netscape Navigator® or Microsoft®’s Internet Explorer to view the help files and Acrobat Reader to view the manuals.

Insert the enclosed CD into your computer and SKP installer will auto-start. The SKP installer program will create a C:\Renesas and C:\Workspace folder on your machine. NC30WA, FoUSB Programmer, Documentation, sample code, and other SKP related files are in the C:\Renesas. HEW is installed in the C:\Program files folder by default.

If the SKP installer program does not start up, browse the CD’s root folder and double-click on ‘***skp_installer.exe***’ to start installation.

3.0 Limited Guarantee and Support

Renesas Technology America, Inc., warrants the SKP16C28 FLGA to be free from component or assembly defect for a period of 180 days from the date of purchase. Settlement is limited to repair or replacement of the product only. Renesas Technology America, Inc., does not assume any liability arising out of the application or use of any product, circuit or procedure described herein. No other liability or warranty apply, expressed or implied. Software warranty is limited to replacement of the CD only. While every attempt has been made to ensure accurate documentation, Renesas Technology America, Inc., cannot be held responsible for error or omissions and reserves the right to make changes without further notice.

“Flash-Over-USB” is a trademark of Renesas Technology America, Inc. All trademarks are the property of their respective owners.

4.0 System Connectivity

The following lists the hardware and software products required for using the SKP16C28 FLGA StarterKit Plus.

- Host Computer (supplied by user)
- SKP16C28 FLGA Board
- RTA-FoUSB-MON (ICD)
- Mini USB Cable
- Target Cable
- Software Tools (HEW IDE, NC30 Compiler/Linker, FoUSB Programmer)

Figure 4-1 shows the system connectivity for the SKP16C28 FLGA.

Figure 4-1 SKP16C28 FLGA System Connectivity

4.1 Host Computer Requirements

The minimum requirement to be able to use the software that comes with the SKP16C28 FLGA is a PC with a USB port and Microsoft Windows 98, ME, 2000, or XP.

4.2 SKP16C28 FLGA Board

The SKP16C28 FLGA board provides an evaluation and development environment for the M16C/28 group MCUs. See section 5.0 'Hardware' for more details.

4.3 In-Circuit Debugger (RTA-FoUSB-MON)

The ICD provides a plug-and-play debugging and programming interface to the SKP16C28 FLGA board via the host computer's Universal Serial Bus (USB). The USB port also provides power to the SKP16C28 FLGA board and ICD thereby eliminating the need for an external power supply.

4.4 Software Development Tools

The SKP installer program installs all the development tools. For details on installation, see the Quick Start Guide or instructions in the Appendix of this manual. A brief description of all the included tools follows. Please refer to the individual Tool manuals for detailed information.

4.4.1 HEW (High-performance Embedded Workshop)

HEW provides a Graphical User Interface (GUI) that integrates the software development tools and includes the C-compiler, assembler, linker, debugger and editor.

4.4.2 NC30WA Evaluation Version C Compiler

The evaluation version of the M3T-NC30WA V.5.30 Release 02 is provided with the same functionality as the commercial version except that link size will be restricted to 64 Kbytes on and after the 61st day from when you begin using the compiler. Contact your local sales representative if you wish to purchase a full license.

4.4.3 Hew Debug Interface

HEW communicates with a kernel (i.e. a ROM monitor program) on the target MCU through the ICD. This debug interface provides a highly efficient evaluation environment. Features include:

- Source-line debug for assembly language C language
- Single step command (does not limit number of breakpoints).
- Run command with **6** breakpoints* for the M16C/28.
- RAM monitor function
- C variable “watch” window

Note: The number of breakpoints will vary depending on the M16C flash MCU used.

4.4.4 FoUSB (Flash-over-USB™) Programmer

The Flash Over USB Programmer application provides In-System Programming capability for the starter kit or any target board using an M16C family flash MCU (i.e.: R8C, M16C, M32C). Please see the RTA-FoUSB-MON Users Manual for more details.

5.0 Hardware

5.1 SKP16C28 FLGA Board

Figure 5-1 shows the SKP16C28 FLGA Board with major components identified.

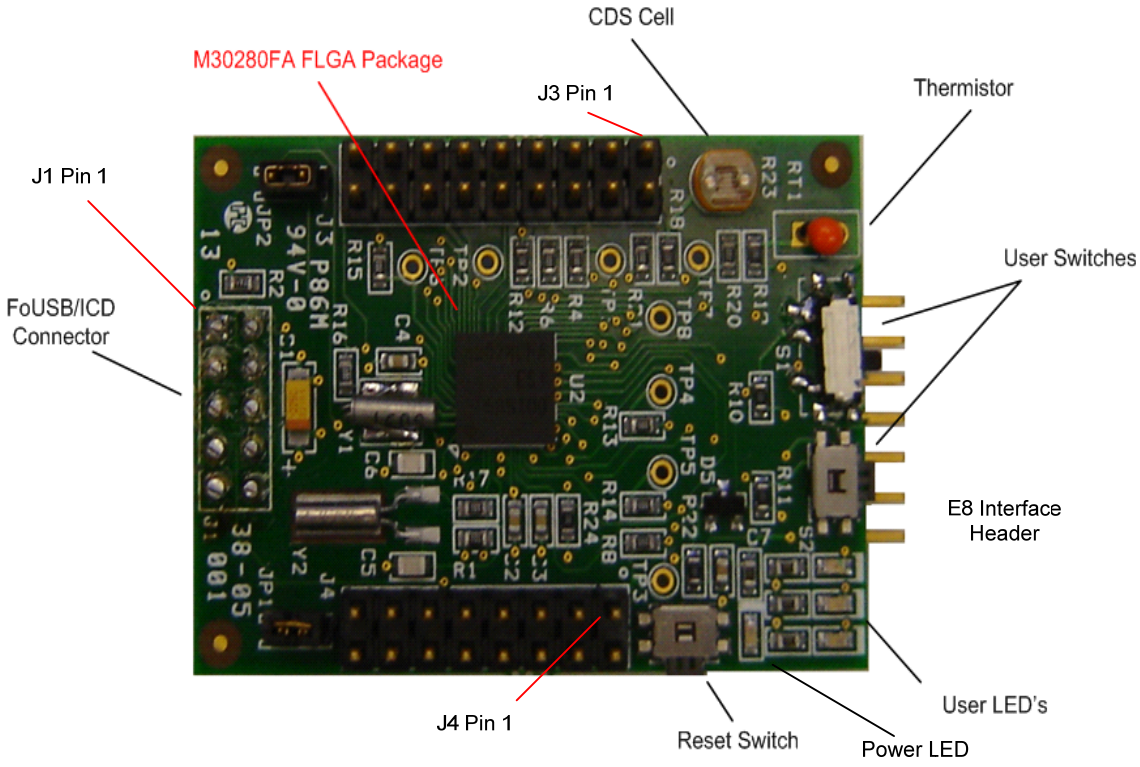


Figure 5-1. SKP16C28 FLGA Board

5.2 SKP16C28 FLGA Board Block Diagram

The SKP16C28 FLGA board incorporates an M30280FA FLGA (80-pin FLGA) from the M16C/28 group of microcontrollers designated as U1. Figure 5-2 shows the SKP16C28 FLGA block diagram.

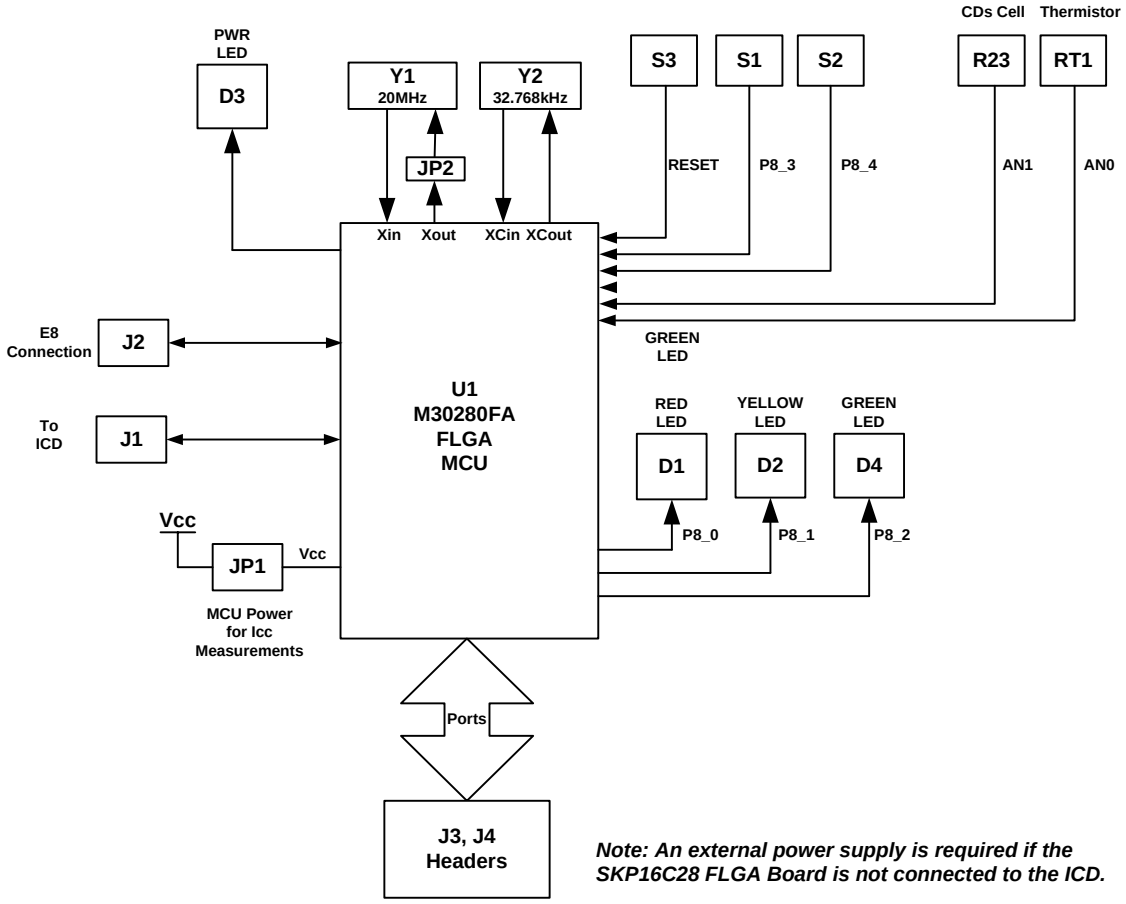


Figure 5-2. SKP16C28 FLGA Board Block Diagram

5.3 M16C/28 Group of MCUs

The M3028x group of 16-bit single-chip, flash microcontrollers (MCU) is part of the M16C/60 series CPU core. The hardware and software manuals for the M16C/28 group of microcontrollers can be found under C:\Renesas\SKP16C28_FLGA\Docs folder in your PC or from the Start menu (Start > Programs > RENESAS-TOOLS > SKP16C28 FLGA > Document Descriptions) after SKP software installation.

5.4 SKP16C28 FLGA Board Jumper Configuration

5.4.1 JP1: MCU (U1) Power

JP1 is used to connect the Vcc pins of the M16C/28 MCU to the Vcc/MCU Power of the board. It can be used to measure current/power consumption of the MCU during various modes of operation. For normal operations, JP1 must be shorted.

JP1 is shorted by default.

5.4.2 JP2: Xout

JP2 is used to connect the output of the MCU's internal amplifier to the crystal for oscillation. It can be used to disconnect Xout when an externally driven clock is connected to Xin. For normal operations, JP2 must be shorted.

JP2 is shorted by default.

5.4.3 Default Jumper Settings

Jumper	JP1 MCU Power	JP2 Xout
Setting	Shorted	Shorted

6.0 System Operation & Limitations

The SKP16C28 FLGA provides sophisticated debugging features at a low cost but it does have some limitations when used with the debugger and ICD. Section 6.1 introduces the kernel (ROM monitor) program and its purpose. The limitations when this kernel is running with the user program are listed in table 6-1.

Table 6-1 System Limitations (when debugging)

Item	Please Refer To
User Limitations	6.2 Pin and Peripheral Limitations
	6.3 Memory Map
	6.4 Register Operation Limitations
	6.5 Limitations on Interrupts
Debugger Limitations	6.6 Stop or Wait Mode Limitations
	6.7 User Program's Real-time Capability

6.1 Kernel (ROM Monitor) Introduction

During debug, a small program, called a kernel, is downloaded to the M16C/28. The kernel communicates with HEW through the ICD regarding MCU status during user code debugging operations.

There are no special steps required in the user program to make use of the ICD. The operation of the kernel is transparent to the user but there are some limitations and these are discussed from section 6.2.

After starting a HEW debug Session, the ICD downloads the kernel to the M16C/28 if it does not exist (e.g. blank device or programmed with FoUSB Programmer). After downloading the kernel, the M16C/28 is ready for downloading user code.

Connecting the ICD without starting HEW will not affect the lines connected between the ICD and the M16C/28 – the ICD keeps the lines in high-impedance state. The ICD only drives the pins after HEW or FoUSB Programmer attempts to connect.

After completing program debug and verification with HEW, you can create an image of your code in Intel (.hex) or Motorola (.mot) file formats. This image can be programmed into the M16C/28 using the FoUSB Programmer. This procedure erases the kernel and leaves only the user program.

6.2 Pin and Peripheral Limitations

SIO/UART1 pins are used for communication between the M16C/28 kernel on the SKP16C28 FLGA board and HEW through the ICD. Do not connect these pins to any other circuit, as UART1 cannot be used in the user program while using the Debugger. For details, please see the RTA-FoUSB-MON (ICD) User Manual on Target M16C ROM Monitor Resources or related ICD application notes.

6.3 Memory Map

The amount and memory locations of the kernel, used on the M16C/28 on the SKP16C28 FLGA board is shown on Figure 6-2.

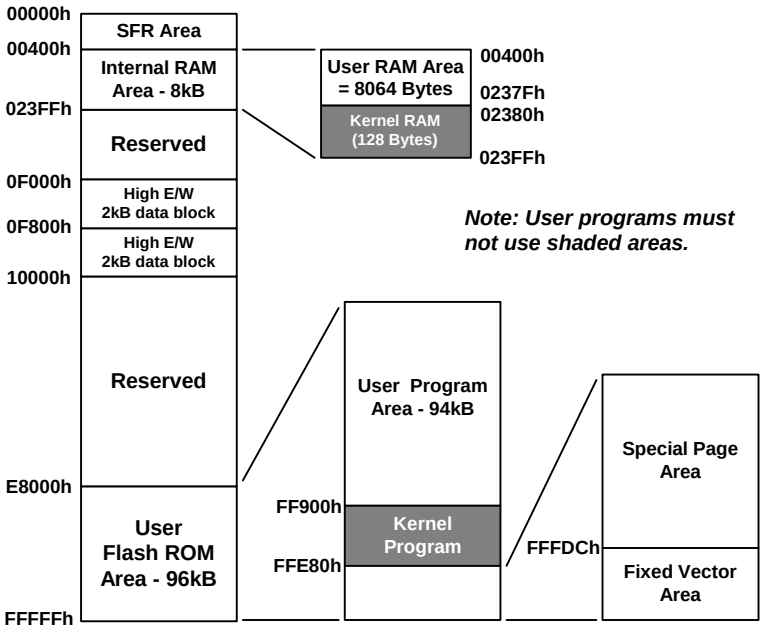


Figure 6-2 M30280FA FLGA Memory Map with the Kernel Program

Note: The kernel occupies memory associated with special-page vector numbers 18-19 and 192-255. The user reset vector is re-mapped to address FFFD8h by the kernel.

6.4 Register Operation Limitations

Table 6-3 lists the limitations on register operation. The registers are inhibited from any modification. If register contents are modified in any way, kernel operation cannot be guaranteed.

Table 6-3. Limitations on Register Operation

Register Name	Restriction
User and Interrupt Stack Pointers	RAM memory range 02380H – 023FFH is used by the kernel. Do not set stacks in this area.
UART1 Transmit/Receive Mode Register UART1 Transmit/Receive Control Register 0 UART1 Transmit/Receive Control Register 1	Do not change
UART1 Interrupt Control Register 0	Do not change
UART Transmit/Receive Control Register 2	Do not change bits 0 and 2
UART1 Transmit Buffer Register	Do not write to this register
UART1 Receive Buffer Register	Do not read this register
Port 6 and Port 6 DDR	To prevent changes on P6_4 data and direction, use read-modify-write only instructions (BSET, BCLR, AND, OR, etc)

6.5 Limitations on Interrupts - Vectors that Reside in the Hardware Vector Table

Table 6-4 lists the limitations on hardware interrupt (i.e. fixed) vector addresses.

Table 6-4. Interrupt Vector Addresses

Interrupt Cause	M16C/28 Vector Address	Kit Specification
Undefined	FFFDCH ~ FFFDFH	User available
Overflow	FFFE0H ~ FFFE3H	User available
BRK Instruction	FFFE4H ~ FFFE7H	User inhibited
Address Match	FFFE8H ~ FFFEBH	User inhibited
Single-step	FFFECH ~ FFFEFH	User inhibited
Watchdog Timer	FFFF0H ~ FFFF3H	User available (Note 1)
DBC	FFFF4H ~ FFFF7H	User inhibited
NMI	FFFF8H ~ FFFFBH	User available
RESET	FFFFCH ~ FFFFFH	Reset vector (Note 2)

NOTES:

(1) The Watchdog Timer vector is shared with the oscillation stop and voltage detection interrupt. The vector is available for oscillation stop and voltage detection interrupts, but avoid using the vector for watchdog timer interrupts.

(2) The kernel transparently relocates the Reset vector to FFFD8H.

6.6 Stop or Wait Mode Limitations

While running the kernel with an application that uses stop or wait modes, care must be taken to not communicate with the MCU while stop or wait is active (avoid RAM monitor or memory window refreshes for example). Breakpoints (if used) should be set at points in the code where it is known that the BCLK is running at a frequency greater than 250Khz.

6.7 User Program's Real-Time Capability

Please be aware that while the kernel is in a "STOP" state, the hardware peripherals will continue to run. Therefore, interrupts may not be serviced properly. Also, the watchdog timer will not be serviced and will likely time out if active.

While the kernel is in a "RUN" state, there is no overhead on the application code UNLESS a RAM monitor window is open. This window requires periodic communication with the MCU. This communication suspends normal application operation while servicing the request (approximately 2000 BCLK cycles for each 16 bytes of data displayed in the window are used per window update). The user must determine whether or not this behavior is acceptable.

6.8 Performing Debug Using Symbols

Normally when a new project is created using HEW, debugging symbols are enabled. If you are unable to view the source properly during debug, add the debug option [**-g**] in HEW before compiling the programs. To enable the [**-g**] option, perform the following:

- Open the workspace and project in HEW.
- Select [Renesas M16C Standard Toolchain] from Options pull-down menu.
- Click on Link tab.
- Select [Output] under the [Category] list box.
- Click on checkbox for [**-g**] 'Outputs source debug information….'
- Click on [OK] button

For more information, see the HEW user's manual.

7.0 SKP16C28 FLGA Board Specifications

7.1 Hardware Specifications

Table 7-1 lists the specifications of the SKP16C28 FLGA Board.

Table 7-1. SKP16C28 FLGA Board Specifications

Item	Specification
MCU	M30280FA FLGA
Clocks	Main Clock: crystal 20MHz, PLL, or ring oscillator Sub Clock: 32.768kHz crystal
Memory (ICD)	RAM: 8kB (8064 Bytes user available due to kernel) High E/W Data Block: 2kB x 2 (4096 Bytes) Flash ROM: 96kB (94kB user available due to kernel)
Connectors	[J1]: Serial interface connector (UART1 for FoUSB-ICD) [J2]: Serial interface connector (UART1 for E8) [J3-J4]: 2, 16/18 pin headers (for user target connection)
Jumpers	[JP1]: MCU Power for Icc Measurements [JP2]: Xout to main crystal Y2
Switches	[S1]: pushbutton (connected to P8_3) [S2]: pushbutton (connected to P8_4) [S3]: pushbutton (connected to Reset)
LED's	[D1] (Red): User output (connected to P8_0) [D2] (Yellow): User output (connected to P8_1) [D4] (Green): User output (connected to P8_2)

7.2 Power Supply Requirements

The SKP16C28 FLGA Board will draw 35mA (max). With the ICD, the current draw will be about 85mA.

7.3 Operating Environment

Table 7-2 lists the environmental conditions for using and storing the SKP16C28 FLGA board. When storing the board, place it in a conductive bag and then in the packing box your product was shipped in from the factory.

Table 7-2. Operating Environment

Environmental Condition	Ambient Temperature	Ambient Humidity
Operating	0 - 55°C (No corrosive gas allowed)	30 to 80% (non-condensing)
Storage	-30 to 75°C (No corrosive gas allowed)	30 to 80% (non-condensing)

Appendix A. Troubleshooting Guide

This section discusses possible problems you may encounter while installing the software (and drivers) and while running the HEW debugger or FoUSB Programmer applications. This section also discusses the countermeasures and solutions to resolve these problems.

If, for any reason, you cannot resolve the problem, please contact your Renesas representative for assistance.

A.1 USB Driver Problems

This section discusses the usual problems with the driver installation and how to fix it. The most common problem encountered is that Windows did not properly install the driver and so the ICD is not recognized. This may also cause the device status to indicate that the device is not working properly. An indication of this problem is the ICD status yellow LED - it blinks about 2-3 times a second. When the driver is installed properly, the yellow LED should only blink every second.

Before trying the following steps, try restarting your PC and see if this resolves the problem. You can check the status using the Device Manager. If the ICD appears under the Universal Serial Bus Controllers with NO red X or yellow exclamation point, the driver was installed properly.

NOTE: If you are using Windows 2000 or XP, you need Administrator privileges to install the drivers.

For cases where the 'Device Status' states the device is not working properly, please try the following:

- Double-click on 'Renesas USB-Monitor' and a Renesas USB-Monitor Properties dialog box appears.
- Click on 'Driver' tab and click on 'Update Driver' button.
- Select 'Display a list…' and click on 'Have Disk' button.
- Specify and locate the 'C:\Renesas\FoUSB\USB Drivers' folder on your PC and install 'usbmon.sys' driver.

If you encounter problems on installing the drivers, you can try the following.

(1) Windows 2000

i. Copy the **fousb.inf** and **usbmon.inf** files from ***\USB Drivers*** folder to \WINNT\INF folder.
ii. Copy the **fousb.sys** and **usbmon.sys** files from ***\USB Drivers*** folder to \WINNT\SYSTEM32\drivers folder.

(2) Windows 98 or XP

i. Copy the **fousb.inf** and **usbmon.inf** files from ***C:\Renesas\FoUSB\USB Drivers*** folder to \WINDOWS\INF folder.
ii. Copy the **fousb.sys** and **usbmon.sys** files from ***C:\Renesas\FoUSB\USB Drivers*** folder to WINDOWS\SYSTEM32\drivers folder.

A.2 Debugging Problems

This section discusses the cause of the problem and countermeasures to resolve it. The common problems encountered with debugging are:

- Erratic debug behavior
- Cannot connect to target
- Issues that may come up during debug operations

A.2.1 Erratic Debug Behavior

HEW allows you to launch multiple “Slave HEW’s”. If more that one HEW is opened in a debug session and/or the FoUSB Programmer software is also running, erratic behavior can result. Having more than one ICD installed can also cause erratic problems or cause HEW to crash.

A.2.2 Cannot Connect to Target

When the message ‘Can’t connect with the target’ is displayed when attempting to connect, there are several reasons that may cause this message to appear. Each cause and the corresponding countermeasure are discussed below.

- The SKP is not connected correctly.

  Please connect the ICD to your PC. Note: Regardless of whether the ICD is bus or target-powered, please connect target board to ICD board first before plugging the USB cable to your PC. Please see section 4 on system (SKP16C28 FLGA) connectivity.

- The ICD has no power (Power LED on ICD is off).

  Please ensure that the Power Mode switch on the ICD is on the ‘USB’ side. In ‘Target’ position, the ICD is powered from the target side.

- USB was not selected on the Init dialog box.

  Please select ‘USB’ from the Init dialog box that is displayed right after you start a debug session.

- The selected MCU on the ICD board and the actual target MCU (M16C/28) do not match.

  Close the error message by clicking on ‘OK’ button, and then click on the ‘Cancel’ button of the Init window. Make sure you select ‘M30280FA.mcu’. If the MCU loaded on the ICD is different, HEW will re-program the ICD to match it.

- The target MCU is damaged.

  Try a different target board and see if the HEW will connect as you may have a damaged board or MCU.

A.2.3 Issues that may come up During Debug Operations

While debugging user code, some issues may come up because the limitations discussed in section 6 were not satisfied. The common issues are listed on table A.2, including the countermeasures.

Table A.2. Problems while Debugging

Problem	Possible Cause/s and Solution
After stepping a few instructions, HEW cannot "stop"	• Changes were made to UART1 SFR's. Do NOT change UART1 SFRs in user program.
Breakpoints do not seem to work	• System is in "FreeRun" mode. Change the RUN mode to "Sampling" from the "Init" window (Emulator System icon).
HEW locks up (cannot stop program) or Communication error message is displayed.	• Changes were made to UART1 SFR's. Do NOT change UART1 SFRs in user program. • Ensure no limitations in Section 6 were violated. • Re-initialize the system without closing debug session. See note below. • Do a hardware reset. User-program runaway may be corrupting the kernel (RAM, interrupt vectors, flags, etc.) Close debug session, hit reset button on the SKP16C28 FLGA to reset the board, and then restart.
Download problems	• Filenames or directory names contain spaces or special characters. • HEW project not properly set up (startup files missing or out of order, files added to wrong member, etc). Try creating a new project and adding your source files to it. For details, please see HEW user's manual.

To re-initialize the system without closing a debug session, try the following:

- Press the [OK] button on the error dialog box to close it.
- When an Exit dialog box appears, press the [Cancel] button to close it.
- Hit reset button on the SKP16C28 FLGA board.
- Click HEW reset Icon.

After initialization, debugging can resume. However, it is recommended that you download your program again before debugging.

Note: If it has been identified that there are problems with the ICD, please see the ICD's (RTA-FoUSB-MON) user's manual and troubleshooting section of this manual.

Appendix B. Reference Manuals

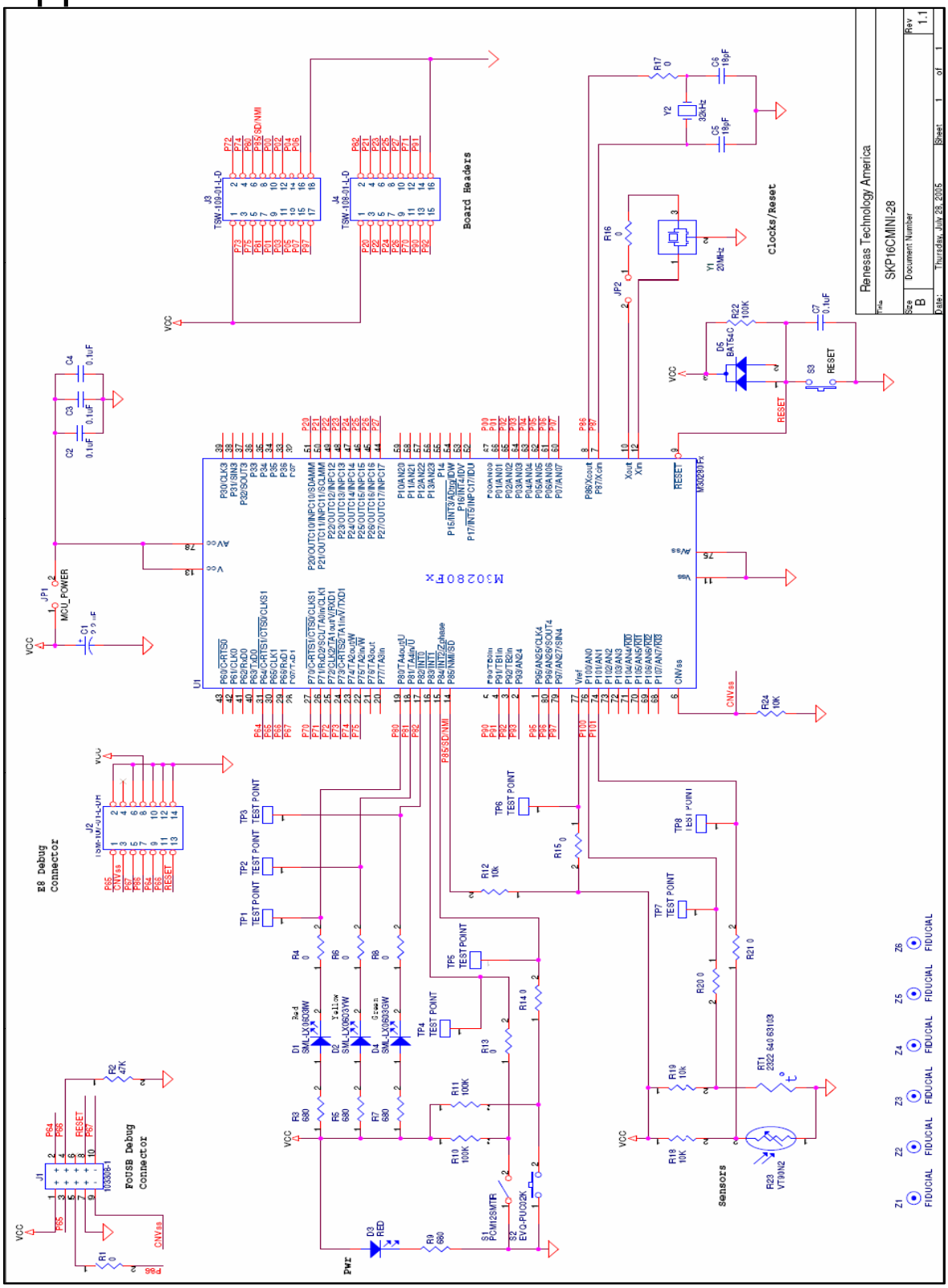
Item	Title	Description
1.	**SKP16C28 FLGA Quick-Start Guide**	Gets you up and running with the SKP16C28 FLGA.
2.	**SKP16C28 FLGA User's Manual**	Installation and operation guide for the SKP16C28 FLGA.
3.	**SKP16C28 FLGA Board Schematic**	Schematic diagram for the SKP16C28 FLGA Starter Kit board.
4.	**SKP16C28 FLGA Board BOM**	Bill of materials for the SKP16C28 FLGA Starter Kit board.
5.	**M16C/28 Group Hardware Manual**	Operation and Specifications for the M16C/28 MCU.
6.	**M16C/20/60 Series C-Language Programming Manual**	ANSI C-language programming guide for the M16C/20/60 series MCUs.
7.	**M16C/20/60 Series Assembler Language Programming Manual**	Assembly language programming guide for the M16C/20/60 series MCUs.
8.	**M16C/20/60 Series Software Manual**	Instruction set manual for the M16C/20/60 series CPU cores.
9.	**M16C/20/60 Series Sample Programs**	Sample programs and application notes for the M16C/20/60 series MCUs.
10.	**HEW User's Manual**	High-performance Embedded Workshop User's Manual.
11.	**AS30 User's Manual**	AS30 Assembler User's Manual.
12.	**NC30 User's Manual**	NC30 C-Compiler User's Manual.
13.	**RTA-FoUSB-MON User's Manual**	In-Circuit Debugger / Flash Programmer User's Manual.

Appendix C. Expansion Headers

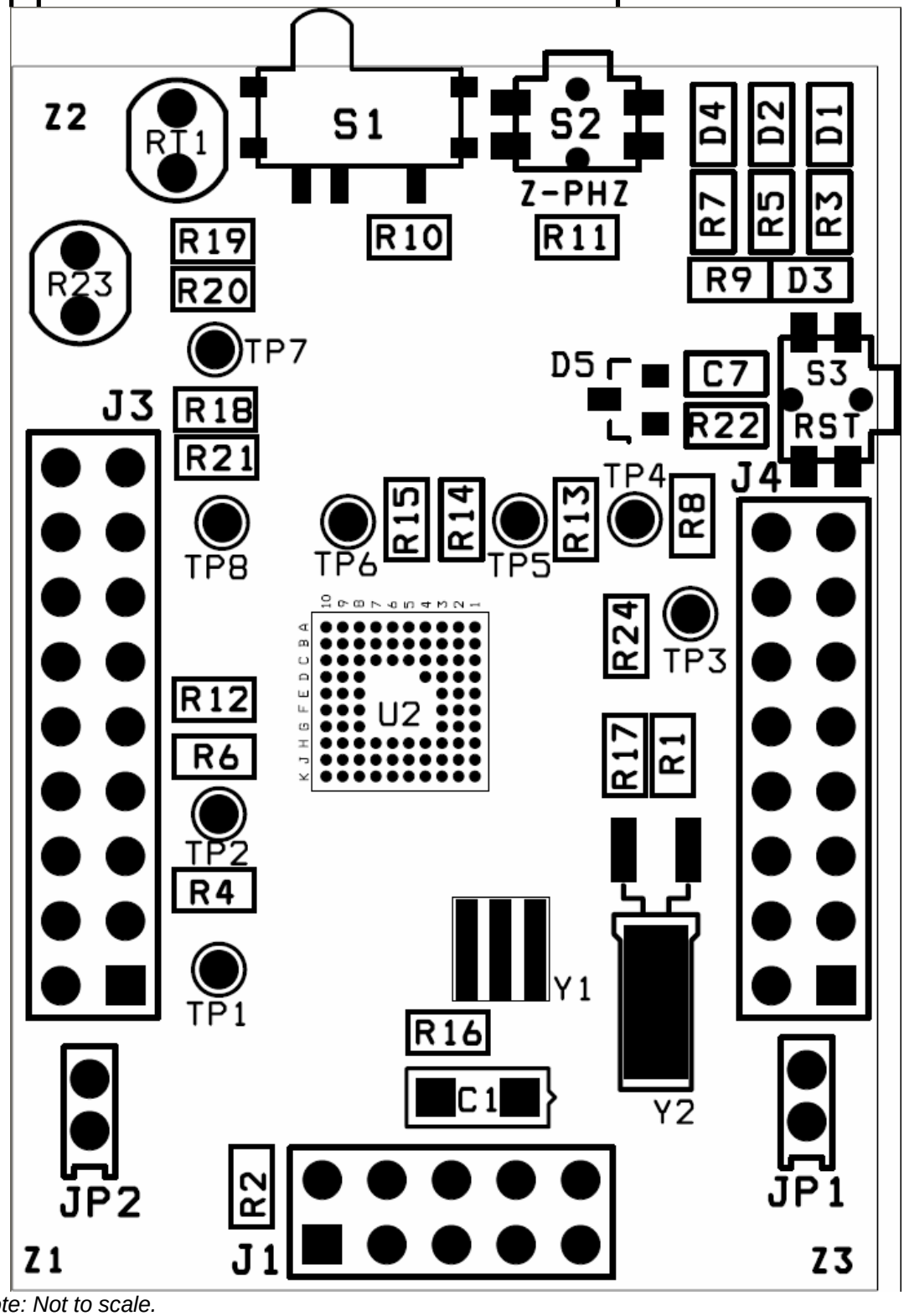
J3 Pin	Function
1	Vcc
2	P7_2
3	P7_3
4	P7_4
5	P7_5
6	P8_0
7	P8_1
8	P8_5
9	P0_1
10	P0_0
11	P0_3
12	P0_2
13	P0_5
14	P0_4
15	P0_7
16	P0_6
17	P9_7
18	GND

J4 Pin	Function
1	Vcc
2	P8_2
3	P2_0
4	P2_1
5	P2_2
6	P2_3
7	P2_4
8	P2_5
9	P2_6
10	P2_7
11	P7_0
12	P7_1
13	P9_0
14	P9_1
15	P9_2
16	GND

Appendix D. SKP16C28 FLGA Schematics



Appendix E. SKP Board Components



Note: Not to scale.

Appendix F. RTA-FoUSB-MON (ICD)

For details on how to use the ICD, please see RTA-FoUSB-MON User's Manual.

For SKP updates, see: www.renesas.com/skp